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XI-XII SCIENCE

JEE (Mains & Adv.) | NEET | MHT-CET

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S6 NEET 2022_Detailed Solution

Physics

Section – A (Compulsory)

1. The dimensions $[MLT^{-2}A^{-2}]$ belong to the

(1) magnetic permeability
(2) electric permittivity
(3) magnetic flux
(4) self inductance

Ans: (1)

Soln: SI unit of magnetic permeability

$\frac{N}{A^2}$ $[M^1L^1T^{-2}A^{-2}]$

2. In a Young's double slit experiment, student observes 8 fringes in a certain segment of screen when a monochromatic light of 600 nm wavelength is used. If the wavelength of light is changed to 400 nm, then the number of fringes he would observe in the same region of the screen is:

(1) 9 (2) 12
(3) 6 (4) 8

Ans: (2)

Soln: $n_1\lambda_1 = n_2\lambda_2$

$\therefore$ $8 \times 600 = n_2 \times 400$

$\therefore$ $\frac{8\times600}{400} = n_2$

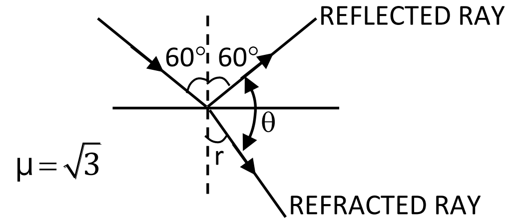
$\therefore$ $n_2 = 12$

3. A light ray falls on a glass surface of refractive index $\sqrt{3}$, at an angle 60°. The angle between the refracted and reflected rays would be:

(1) 90° (2) 120°
(3) 30° (4) 60°

Ans: (1)

Soln:



Angle of incidence = Angle of reflection

$\therefore$ i = r = 60°

Now,

$\mu = \frac{\sin i}{\sin r'} \Rightarrow \sin r' = \frac{\sin 60}{\sqrt{3}} = \frac{1}{2} = r' = 30°$

Now,

$60 + \theta + r' = 180° \Rightarrow 60 + \theta + 30 = 180°$

$\Rightarrow$ $\theta = 90°$

4. A long solenoid of radius 1 mm has 100 turns per mm. If 1 A current flows in the solenoid, the magnetic field strength at the centre of the solenoid is:

(1) 12.56×10^{-4} T (2) 6.28×10^{-4} T
(3) 6.28×10^{-2} T (4) 12.56×10^{-2} T

Ans: (4)

Soln: $B = \mu_0 \cdot n \cdot i$

$= 4\pi \times 10^{-7} \times \frac{100}{10^{-3}} \times 1$

$= 4\pi \times 10^{-2} = \mathbf{12.56 \times 10^{-2}\ T}$

5. The angular speed of a fly wheel moving with uniform angular acceleration changes from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration in rad/s² is:

(1) 12π (2) 104π
(3) 2π (4) 4π

Ans: (4)

Soln: $\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{(3120-1200)}{16} \times \frac{2\pi}{60}$

$= \frac{1920}{16} \times \frac{2\pi}{60}$ = **4π rad/s²**

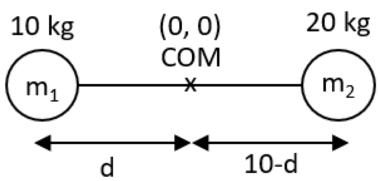
6. Two objects of mass 10 kg and 20 kg respectively are connected to the two ends of a rigid rod of length 10 m with negligible mass. The distance of the center of mass of the system from the 10 kg mass is:

(1) 10 m (2) 5 m

(3) $\frac{10}{3}$m (4) $\frac{20}{3}$m

Ans: (4)

Soln:



$X_{COM} = \frac{M_1X_1 + M_2X_2}{M_1 + M_2}$

$0 = \frac{10(-d) + 20(10-d)}{10+20}$

$\therefore$ $0 = -10d + 200 - 20d$

$\therefore$ $30d = 200 \Rightarrow d = \frac{200}{30} = \frac{20}{3}$m

7. In half wave rectification, if the input frequency is 60 Hz, then the output frequency would be:

(1) 60 Hz (2) 120 Hz

(3) zero (4) 30 Hz

Ans: (1)

Soln: During half wave rectification, frequency remains same

8. Plane angle and solid angle have:

(1) No units and no dimensions

(2) Both units and dimensions

(3) Units but no dimensions

(4) Dimensions but no units

Ans: (3)

Soln: SI unit of plane angle and solid angle are radian and steradian But they are dimensionless

9. The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is

(1) 36×10^5 J (2) 1×10^5 J

(3) 36×10^7 J (4) 36×10^4 J

Ans: (3)

Soln: $P = \frac{E}{t}$

$\therefore$ $E = P \cdot t = 100 \times 10^3 \times 1 \times 60 \times 60$

$= 3600 \times 10^5$

$= 36 \times 10^7$ J

10. When two monochromatic lights of frequency, ν and $\frac{\nu}{2}$ are incident on a photoelectric metal, their stopping potential becomes $\frac{V_s}{2}$ and V_s respectively. The threshold frequency for the metal is:

(1) $\frac{2}{3}\nu$ (2) $\frac{3}{2}\nu$

(3) 2ν (4) 3ν

Ans: (2)

Soln: $eV_0 = h\nu - h\nu_0$

$e\frac{V_s}{2} = h\nu - h\nu_0$ ..... (i)

$eV_s = h\frac{\nu}{2} - h\nu_0$ ..... (ii)

from eq (ii) Substitute in eq (i)

$\frac{\left(h\frac{\nu}{2} - h\nu_0\right)}{2} = h\nu - h\nu_0$

$\therefore$ $\frac{h\nu}{2} - h\nu_0 = 2h\nu - 2h\nu_0$

$\therefore$ $h\nu_0 = 2h\nu - \frac{h\nu}{2} = \frac{3}{2}h\nu$

$\therefore$ $\nu_0 = \frac{3}{2}\nu$

11. If the initial tension on a stretched string is doubled, then the ratio of the initial and final speeds of a transverse wave along the string is:

(1) $1 : \sqrt{2}$ (2) $1 : 2$
(3) $1 : 1$ (4) $\sqrt{2} : 1$

Ans: (1)

Soln: $V = \sqrt{\frac{T}{\mu}}$

$\therefore \quad \frac{V_i}{V_f} = \sqrt{\frac{T_i}{T_f}} = \sqrt{\frac{T_i}{2T_i}}$

$\therefore \quad \frac{V_i}{V_f} = \frac{1}{\sqrt{2}}$

12. A square loop of side 1 m and resistance 1 Ω is placed in a magnetic field of 0.5 T. If the plane of loop is perpendicular to the direction of magnetic field, the magnetic flux through the loop is:

(1) 1 weber (2) zero weber
(3) 2 weber (4) 0.5 weber

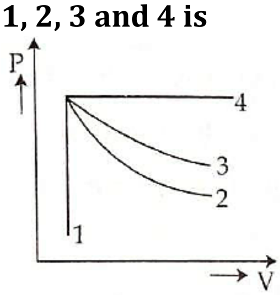
Ans: (4)

Soln: $\phi = BA \cos \theta$

$= 0.5 \times (1)^2 \times \cos 0$ ($\because \overline{B} || \overline{A}$)

$= 0.5$ weber (Area vector is $\perp$ r to plane of loop)

13. An ideal gas undergoes four different processes from the same initial state as shown in the figure below. Those processes are adiabatic, isothermal, isobaric and isochoric. The curve which represents the adiabatic process among 1, 2, 3 and 4 is



(1) 3 (2) 4
(3) 1 (4) 2

Ans: (4)

Soln: Slope of Adiabatic curve is greater than slope of isothermal curve.

14. Given below are two statements:

Statement I: Biot-Savart's law gives us the expression for the magnetic field strength of an infinitesimal current element (Idl) of a current carrying conductor only.

Statement II: Biot-Savart's law is analogous to Coulomb's inverse square law of charge q, with the former being related to the field produced by a scalar source, Idl while the latter being produced by a vector source, q. In light of above statements choose the most appropriate answer from the options given

(1) Statement I is correct and Statement II is incorrect
(2) Statement I is incorrect and Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

Ans: (4)

Soln: Biot and savart's law can be used to find $\vec{B}$ due to long conductor

Statement II : Incorrect

Biot and Savart's law is related to field produced by vector source ($I\vec{d\ell}$)

15. A shell of mass m is at rest initially. It explodes into three fragments having mass in the ratio 2 : 2 : 1. If the fragments having equal mass fly off along mutually perpendicular directions with speed υ, the speed of the third (lighter) fragment is:

(1) $2\sqrt{2}\upsilon$ (2) $3\sqrt{2}\upsilon$
(3) υ (4) $\sqrt{2}\upsilon$

Ans: (1)

Soln: $\vec{P_i} = \vec{P_f}$

$0 = 2m V_1 \hat{i} + 2mV_2\hat{j} + m\vec{V_3}$

$\therefore \quad 0 = 2mV\hat{i} + 2mV\hat{j} + m\vec{V_3}$

$\therefore \quad \vec{V_3} = -2V\hat{i} - 2V\hat{j}$

$V_3 = \sqrt{4V^2 + 4V^2} = 2\sqrt{2}V$

16. Two resistors of resistance, 100 Ω and 200 Ω are connected in parallel in an electrical circuit. The ratio of the thermal energy developed in 100 Ω to that in 200 Ω in a given time is:

(1) 1 : 4 (2) 4 : 1
(3) 1 : 2 (4) 2 : 1

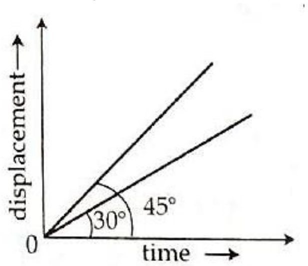
Ans: (4)

Soln: In parallel, P.D. across both the resistors will be equal

$\therefore \quad H = \dfrac{V^2 t}{R}$

$\therefore \quad \dfrac{H_1}{H_2} = \left(\dfrac{R_2}{R_1}\right) = \dfrac{200}{100} = \dfrac{2}{1}$

17. The displacement – time graphs of two moving particles make angles of 30° and 45° with the x-axis as shown in the figure. The ratio of their respective velocity is:



(1) 1 : 2 (2) $1 : \sqrt{3}$
(3) $\sqrt{3} : 1$ (4) 1 : 1

Ans: (2)

Soln: Slope of X v/s t graph gives velocity

$\therefore \quad V = \tan\theta$

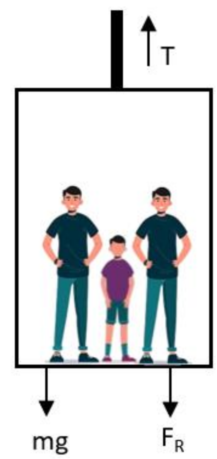
$\dfrac{V_1}{V_2} = \dfrac{\tan\theta_1}{\tan\theta_2} = \dfrac{\tan 30}{\tan 45} = \dfrac{1}{\sqrt{3}}$

18. An electric lift with a maximum load of 2000 kg (lift + passengers) is moving up with a constant speed of 1.5 ms⁻¹. The frictional force opposing the motion is 3000 N. The minimum power delivered by the motor to the lift in watts is: ($g = 10\ ms^{-2}$)

(1) 34500 (2) 23500
(3) 23000 (4) 20000

Ans: (1)

Soln:



Force applied by wire on lift

$T = mg + F_R = 2000 \times 10 + 3000$

$= 23000$ N

$P = FV \cos\theta$

$= (23000)(1.5) \cos 0$

$= 34500$ W

19. If a soap bubble expands, the pressure inside the bubble:

(1) remains the same
(2) is equal to the atmospheric pressure
(3) decreases
(4) increases

Ans: (3)

Soln: $(P_i - P_0) = \dfrac{4T}{r}$

$r\uparrow \Rightarrow$ Excess Pressure $\downarrow \Rightarrow P_i \downarrow$

20. The ratio of the radius of gyration of a thin uniform disc about an axis passing through its centre and normal to its plane to the radius of gyration of the disc about its diameter is:

(1) 4 : 1 (2) $1:\sqrt{2}$

(3) 2 : 1 (4) $\sqrt{2}:1$

Ans: (4)

Soln: $I = MK^2 \Rightarrow K = \sqrt{\frac{I}{M}}$

$$\frac{K_{COM}}{K_{Dia}} = \sqrt{\frac{I_{COM}}{I_{Dia}}} = \sqrt{\frac{\frac{MR^2}{2}}{\frac{MR^2}{4}}} = \sqrt{\frac{2}{1}}$$

21. When light propagates through a material medium of relative permittivity ϵ_r and relative permeability μ_r, the velocity of light, υ is given by : (c – velocity of light in vacuum)

(1) $\upsilon = \sqrt{\frac{\epsilon_r}{\mu_r}}$ (2) $\upsilon = \frac{c}{\sqrt{\epsilon_r \mu_r}}$

(3) $\upsilon = c$ (4) $\omega\upsilon = \sqrt{\frac{\mu_r}{\epsilon_r}}$

Ans: (2)

Soln: $V = \frac{1}{\sqrt{\mu\epsilon}} = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}} = \frac{C}{\sqrt{\mu_r\epsilon_r}}$

$$\left(\because C = \frac{1}{\sqrt{\mu_0\epsilon_0}}\right)$$

22. Two hollow conducting spheres of radii R_1 and R_2 ($R_1 >> R_2$) have equal charges. The potential would be:

(1) equal on both the spheres

(2) dependent on the material property of the sphere

(3) more on bigger sphere

(4) more on smaller sphere

Ans: (4)

Soln: $V = \frac{K \cdot Q}{R}$

$R_1 >> R_2 \Rightarrow V_1 << V_2$

23. A biconvex lens has radii of curvature, 20 cm each. If the refractive index of the material of the lens is 1.5, the power of the lens is:

(1) +5D (2) infinity

(3) + 2D (4) + 20D

Ans: (1)

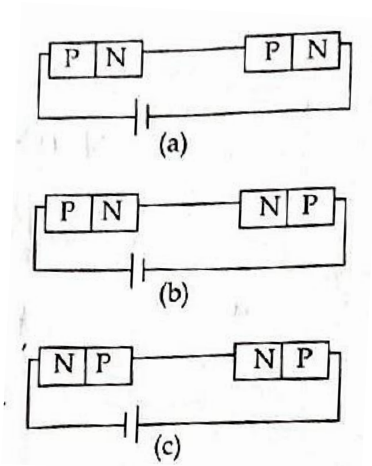
Soln: $P = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$= (1.5-1)\left(\frac{1}{20}+\frac{1}{20}\right)\times\frac{1}{10^{-2}}$$

$$= 0.5\left(\frac{1}{10}\right)\times 10^2$$

$$= \frac{1}{20}\times 10^2 = +5D$$

24.



In the given circuits (a), (b) and (c), the potential drop across the two p-n junctions are equal in

(1) Circuit (c) only

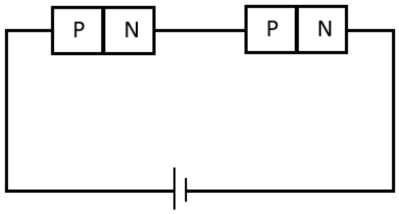
(2) Both circuits (a) and (c)

(3) Circuit (a) only

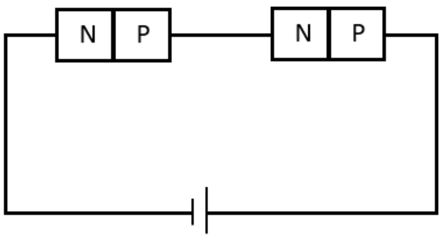
(4) Circuit (b) only

Ans: (2)

Soln:

(a) 

Forward Biased

(c) 

Forward Biased

Potential difference will be equal in both the cases

25. The peak voltage of the ac source is equal to:

(1) $\sqrt{2}$ times the rms value of the ac source

(2) $1/\sqrt{2}$ times the rms value of the ac source

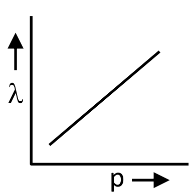
(3) the value of voltage supplied to the circuit

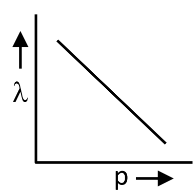
(4) the rms value of the ac source

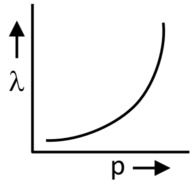
Ans: (1)

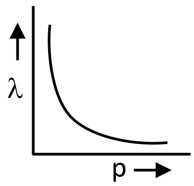
Soln: $V_0 = \sqrt{2}\ V_{RMS}$

26. The graph which shows the variation of the de Broglie wavelength (λ) of a particle and its associated momentum (p) is :

(1) 

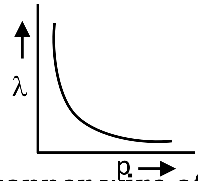
(2) 

(3) 

(4) 

Ans: (4)

Soln: $\lambda = \dfrac{h}{p} \Rightarrow \lambda \propto \dfrac{1}{p}$



27. A copper wire of length 10 m and radius $(10^{-2}/\sqrt{\pi})$ m has electrical resistance of 10 Ω. The current density in the wire for an electric field strength of 10 (V/m) is:

(1) 10^{-5} A/m² (2) 10^5 A/m²

(3) 10^4 A/m² (4) 10^6 A/m²

Ans: (2)

Soln: $J = \sigma \cdot E$

$$J = \frac{E}{\rho} = \frac{E \cdot L}{R \cdot A}$$

$$J = \frac{10 \times 10}{10 \times \pi \times \left(\frac{10^{-2}}{\sqrt{\pi}}\right)^2}$$

$$J = \frac{10}{\pi \times \frac{10^{-4}}{\pi}}$$

$$J = 10^5 \text{ A/m}^2$$

28. In the given nuclear reaction, the element X is:

$${}^{22}_{11}Na \rightarrow X + e^+ + \nu$$

(1) ${}^{22}_{10}Ne$ (2) ${}^{22}_{12}Mg$

(3) ${}^{23}_{11}Na$ (4) ${}^{23}_{10}Ne$

Ans: (1)

Soln: ${}^{22}_{11}Na \rightarrow X + {}^{0}_{1}e + \nu$

${}^{22}_{10}X \Rightarrow {}^{22}_{10}Ne$

29. The ratio of the distances travelled by a freely falling body in the 1st, 2nd, 3rd and 4th second:

(1) 1 : 3 : 5 : 7 (2) 1 : 1 : 1 : 1

(3) 1 : 2 : 3 : 4 (4) 1 : 4 : 9 : 16

Ans: (1)

Soln: 1 : 3 : 5 : 7

30. As the temperature increases, the electrical resistance:

(1) increases for conductors but decreases for semiconductors
(2) decreases for conductors but increases for semiconductors
(3) increases for both conductors and semiconductors
(4) decreases for both conductors and semiconductors

Ans: (1)

Soln: $T \uparrow \Rightarrow R \uparrow$ For conductors
$T \uparrow \Rightarrow R \downarrow$ For semiconductors

31. The angle between the electric lines of force and the equipotential surface is:

(1) 90° (2) 180°
(3) 0° (4) 45°

Ans: (1)

Soln: Electric Lines of forces are perpendicular on equi-potential surface

32. Let T_1 and T_2 be the energy of an electron in the first and second excited states of hydrogen atom, respectively. According to the Bohr's model of an atom, the ratio $T_1 : T_2$ is:

(1) 4 : 9 (2) 9 : 4
(3) 1 : 4 (4) 4 : 1

Ans: (2)

Soln: $E_n = \dfrac{-13.6Z^2}{n^2}$

Z = 1 for Hydrogen

$$\frac{E_1}{E_2} = \left(\frac{n_2}{n_1}\right)^2 = \left(\frac{3}{2}\right) = \frac{9}{4}$$

First excited state $n_1 = 2$
Second excited state $n_2 = 3$

33. Match List – I with List – II:

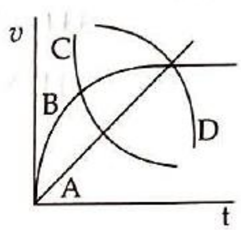
	List-I		List-II
(A)	AM radio waves	(i)	10^{-10} m
(B)	Microwaves	(ii)	10^2 m
(C)	Infrared radiations	(iii)	10^{-2} m
(D)	X-rays	(iv)	10^{-4}

(1) (A)–(iii), (B)–(iv), (C)–(ii), (D)–(ii)
(2) (A)–(ii), (B)–(iii), (C)–(iv), (D)–(i)
(3) (A)–(iv), (B)–(iii), (C)–(ii), (D)–(i)
(4) (A)–(iii), (B)–(ii), (C)–(i), (D)–(iv)

Ans: (2)

Soln: AM Radio Waves : 10^2m (100 m)
Microwaves : 10^{-2} m
IR Radiation : 10^{-4}m
X-rays : 10^{-10} m (1A°)

34. A spherical ball is dropped in a long column of a highly viscous liquid. The curve in the graph shown, which represents the speed of the ball (v) as a function of time (t) is:



(1) C (2) D
(3) A (4) B

Ans: (4)

Soln: After sometime, speed becomes constant called as terminal velocity

∴ **Curve B**

35. A body of mass 60 g experiences a gravitational force of 3.0 N, when placed at a particular point. The magnitude of the gravitational field intensity at that point is:

(1) 20 N/kg (2) 180 N/kg
(3) 0.05 N/kg (4) 50 N/kg

Ans: (4)

Soln: $I = \dfrac{F}{M} = \dfrac{3}{60 \times 10^{-3}}$

$= \dfrac{1}{20} \times 1000 = 50$ N/kg

Section – B (Attempt Any 10)

36. The volume occupied by the molecules contained in 4.5 kg water at STP, if the intermolecular forces vanish away is:

(1) 5.6×10^{-3} m³ (2) 5.6 m³
(3) 5.6×10^{6} m³ (4) 5.6×10^{3} m³

Ans: (2)

Soln: PV = n · R · T

$$1 \times 10^5 \times V = \frac{4.5\times10^3}{18}\times8.3\times273$$

$$\left(\because n = \frac{M}{M_0}\right)$$

$$\therefore \quad V = \frac{4.5\times10^3\times8.3\times273}{18\times10^5}$$

$\therefore$ V = 566.4×10^{-2}

$\therefore$ V = 5.6 m³

37. Match List – I with List – II:

	List-I		List-II
(A)	Gravitational constant (G)	(i)	$[L^2T^{-2}]$
(B)	Gravitational potential energy	(ii)	$[M^{-1}L^3T^{-2}]$
(C)	Gravitational potential	(iii)	$[LT^{-2}]$
(D)	Gravitational intensity	(iv)	$[ML^2T^{-2}]$

(1) (A)–(ii), (B)–(iv), (C)–(iii), (D)–(i)
(2) (A)–(iv), (B)–(ii), (C)–(i), (D)–(iii)
(3) (A)–(ii), (B)–(i), (C)–(iv), (D)–(iii)
(4) (A)–(ii), (B)–(iv), (C)–(i), (D)–(iii)

Ans: (4)

Soln: Gravitational constant

$$G = \frac{F\cdot r^2}{m_1\cdot m_2} = \frac{[M^1L^1T^{-2}][L^2]}{[M^2]}$$

$[G] = [M^{-1}L^3T^{-2}]$

Gravitational PE = $[M^1L^2T^{-2}]$

Gravitational Potential

$$V = \frac{W}{m} = \frac{[M^1L^2T^{-2}]}{[M^1]} = [M^0\,L^2\,T^{-2}]$$

Gravitational Intensity

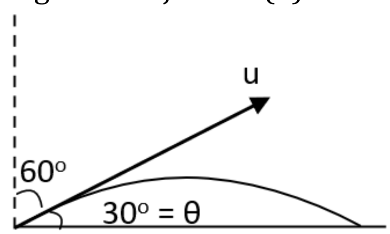
$$I = \frac{F}{M} = \frac{[M^1L^1T^{-2}]}{[M^1]} = [M^0\,L^1\,T^{-2}]$$

38. A ball is projected with a velocity, 10 ms⁻¹, at angle of 60° with the vertical direction. Its speed the highest point of its trajectory will be:

(1) 5 ms^{-1} (2) 10 ms^{-1}
(3) zero (4) $5\sqrt{3}$ ms^{-1}

Ans: (4)

Soln: Angle of Projection (θ) = 90° – 60° = 30°



Speed at Highest Point = $u\cos\theta$

$= 10 \cos 30°$

$= 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3}$

39. Two transparent media A and B are separated by a plane boundary. The speed of light in those media are 1.5×10^8 m/s and 2.0×10^8 m/s, respectively. The critical angle for a ray of light for these two media is:

(1) $\tan^{-1}(0.500)$ (2) $\tan^{-1}(0.750)$
(3) $\sin^{-1}(0.500)$ (4) $\sin^{-1}(0.750)$

Ans: (4)

Soln: A → Denser Medium

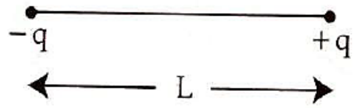
B → Rarer Medium

$${}^{A}\mu_B = \frac{V_A}{V_B} = \frac{1.5\times10^8}{2\times10^8} = \frac{3}{4} = \frac{\mu_B}{\mu_A}$$

$$\text{Sin}(i_C) = \frac{\mu_B}{\mu_A} = \frac{3}{4}$$

$i_C = \sin^{-1}(0.75)$

40. Two point charges – q and +q are placed at a distance of L, as shown in the figure.



The magnitude of electric field intensity at a distance R (R >> L) varies as:

(1) $\frac{1}{R^4}$ (2) $\frac{1}{R^6}$

(3) $\frac{1}{R^2}$ (4) $\frac{1}{R^3}$

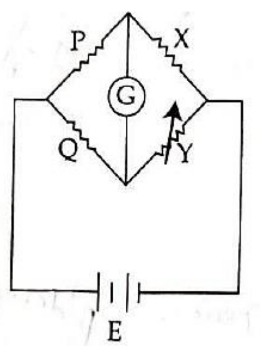
Ans: (4)

Soln: R >> L

It behaves as short dipole

$E \propto \frac{1}{r^3}$

41. A wheatstone bridge is used to determine the value of unknown resistance X by adjusting the variable resistance Y as shown in the figure. For the most precise measurement of X, the resistances P and Q:



(1) should be very large and unequal
(2) do not play any significant role
(3) should be approximately equal to 2X
(4) should be approximately equal and are small

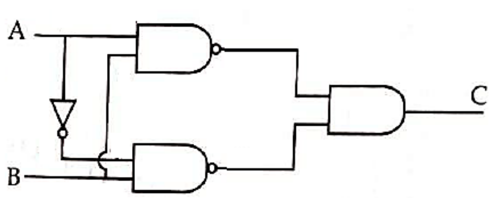
Ans: (4)

Soln: For highest Accuracy

$\frac{P}{Q} = \frac{X}{Y} = 1$

$\therefore$ P = Q

42.



The truth table for the given logic circuits is:

(1)

A	B	C
0	0	1
0	1	0
1	0	1
1	1	0

(2)

A	B	C
0	0	0
0	1	1
1	0	0
1	1	1

(3)

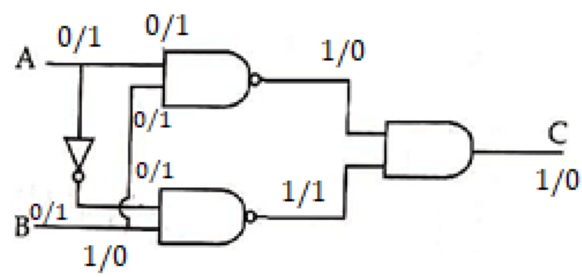
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

(4)

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

Ans: (1)

Soln:



43. A nucleus of mass number 189 splits into two nuclei having mass number 125 and 64. The ratio of radius of two daughter nuclei respectively is:

(1) 5 : 4 (2) 25 : 16

(3) 1 : 1 (4) 4 : 5

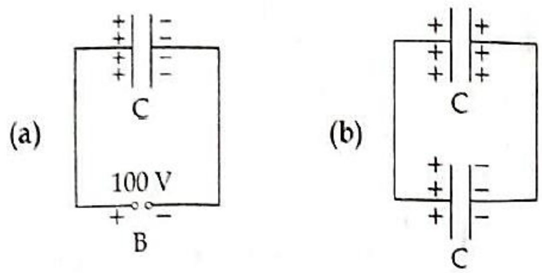
Ans: (1)

Soln: Radius of Nucleus

$R = R_0 (A)^{1/3}$

$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{125}{64}\right)^{1/3} = \frac{5}{4}$

44. A capacitor of capacitance C = 900 pF is charged fully by 100 V battery B as shown in figure (a). Then it is disconnected from the battery and connected to another uncharged capacitor of capacitance C = 900 pF as shown in figure (b). The electrostatic energy stored by the system (b) is:



(1) 2.25×10^{-6} J (2) 1.5×10^{-6} J
(3) 4.5×10^{-6} J (4) 3.25×10^{-6} J

Ans: (1)

Soln: Q. remains same

$\therefore$ $Q = C \cdot V$

$= 900 \times 10^{-12} \times 100 = 900 \times 10^{-10}$

Now,

In circuit (b)

Both capacitor are in parallel

$C_p = 2C = 2 \times 900 = 1800\text{pF}$

$$U = \frac{Q^2}{2C_p} = \frac{(900 \times 10^{-10})^2}{2 \times 1800 \times 10^{-12}}$$

$$= \frac{81 \times 10^4 \times 10^{-20}}{2 \times 18 \times 10^{-10}} = 2.25 \times 10^{-6}\ \text{J}$$

45. The area of a rectangular field (in m²) of length 55.3 m and breadth 25 m after rounding off the value for correct significant digits is:

(1) 1382.5 (2) 14×10^2
(3) 138×10^1 (4) 1382

Ans: (2)

Soln: L = 55.3 m (3 significant digit)

b = 25 m (2 significant Digit)

While multiplying, answer must posses least significant digits

$\therefore$ $1382.5 = 13.825 \times 10^2 = 14 \times 10^2$

46. Two pendulums of length 121 cm and 100 cm start vibrating in phase. At some instant, the two are at their mean position in the same phase. The minimum number of vibrations of the shorter pendulum after which the two are again in phase at the mean position is:

(1) 10 (2) 8
(3) 11 (4) 9

Ans: (3)

Soln: $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$\frac{T_1}{T_2} = \sqrt{\frac{\ell_1}{\ell_2}} = \sqrt{\frac{121}{100}} = \frac{11}{10}$$

$10T_1 = 11T_2$

$\therefore$ $n_1T_1 = (n_1 + 1)T_2$

After n_1 vibration of longer and $(n_1 + 1)$ vibration of shorter. They will be in same phase.

$\therefore$ $(n_1 + 1) = 11$

47. A series LCR circuit with inductance 10 H, capacitance 10μF, resistance 50 Ω is connected to an ac source of voltage, V = 200 sin (100 t) volt. If the resonant frequency of the LCR circuit is ν₀ and the frequency of the ac source is ν, then:

(1) $\nu_0 = \frac{50}{\pi}\text{Hz}, \nu = 50\text{Hz}$

(2) $\nu = 100\text{Hz}; \nu_0 = \frac{100}{\pi}\text{Hz}$

(3) $\nu_0 = \nu = 50$ Hz

(4) $\nu_0 = \nu = \frac{50}{\pi}\text{Hz}$

Ans: (4)

Soln: $\nu_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{10 \times 10 \times 10^{-6}}}$

$$= \frac{1}{2\pi \times \sqrt{10^{-4}}} = \frac{10^2}{2\pi} = \frac{50}{\pi}$$

$\omega = 100 = 2\pi\nu$

$$\nu = \frac{100}{2\pi} = \frac{50}{\pi}$$

$$\nu = \nu_0 = \frac{50}{\pi}$$

48. From Ampere's circuital law for a long straight wire of circular cross-section carrying a steady current, the variation of magnetic field in the inside and outside region of the wire is:

(1) a linearly increasing function of distance r upto the boundary of the wire and then decreasing one with 1/r dependence for the outside region.

(2) a linearly decreasing function of distance upto the boundary of the wire and then a linearly increasing one for the outside region.

(3) uniform and remains constant for both the regions.

(4) a linearly increasing function of distance upto the boundary of the wire and then linearly decreasing for the outside region

Ans: (1)

Soln: $B_{in} = \frac{\mu_0 Ir}{2\pi R^2} \Rightarrow B_{in} \propto r$

$B_{out} = \frac{\mu_0 I}{2r} \Rightarrow B_{out} \propto \frac{1}{r}$

49. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The stretching of a spring is determined by the shear modulus of the material of the spring.

Reason (R): A coil spring of copper has more tensile strength than a steel spring of same dimensions.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) (A) is true but (R) is false

(2) (A) is false but (R) is true

(3) Both (A) and (R) are true and (R) is the correct explanation of (A)

(4) Both (A) and (R) are true and (R) is not the correct explanation of (A)

Ans: (1)

Soln: (A) → True (stretching of coil changes the shapes)

(B) → False (Tensile strength of steel greater than copper)

50. A big circular coil of 1000 turns and average radius 10 m is rotating about its horizontal diameter at 2 rad s^{-1}. If the vertical component of earth's magnetic field at that place is 2×10^{-5} T and electrical resistance of the coil is 12.56Ω, then the maximum induced current in the coil will be:

(1) 1 A (2) 0.25 A

(3) 0.25 A (4) 1.5 A

Ans: (1)

Soln: $i = \left|\frac{e}{R}\right| = \left|\frac{1}{R}\cdot\frac{d\phi}{dt}\right| = \left|\frac{1}{R}\cdot\frac{d}{dt}(N.BA\cos\theta)\right|$

$i = \left|\frac{1}{R}\cdot N\cdot B\cdot A(-\sin\theta)\cdot\frac{d\theta}{dt}\right|$

$i_{max} = \frac{N\cdot B\cdot A\cdot\omega}{R}$ ($\because$ sin θ = 1 max. value)

$= \frac{1000\times 2\times 10^{-5}\times\pi\times(10)^2\times 2}{12.56} = \frac{4\pi}{12.56}$

= 1 A